JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 1972, 18, 323-332 NUMBER 2 (SEPTEMBER)

SHOCK-INDUCED AGGRESSION AS A FUNCTION OF PRIOR EXPERIENCE WITH AVOIDANCE, FIGHTING, OR UNAVOIDABLE SHOCK[1]

D. A. POWELL,[2] M. J. FRANCIS, J. FRANCIS, AND N. SCHNEIDERMAN

VETERANS ADMINISTRATION HOSPITAL, COLUMBIA, S.C.
AND UNIVERSITY OF MIAMI

Rats were trained in shock-induced aggression, free operant avoidance, or were presented with unavoidable shocks. Fighting in response to shock was subsequently measured by intermatching individual animals that had received the three training procedures. The fighting probabilities of animals with histories of avoidance and dominant animals with histories of fighting were higher than the fighting probabilities of non-dominant fighting rats or rats with a history of unavoidable shocks. Animals with higher fighting probabilities disrupted avoidance baselines more than animals with lower fighting probabilities. Control experiments suggested that fighting decrements produced by administration of prior grid-shock were due to the acquisition of behaviors incompatible with aggression.

Although fighting elicited by electric shock has obvious respondent characteristics (Ulrich and Azrin, 1962), past experience with fighting and shock has been shown to be related to the frequency of such attacks (Powell and Creer, 1969). For example, single animals presented with inescapable shocks showed decrements in their later shock-induced fighting rates (Powell and Creer, 1969), whereas animals with prior exposure to shock-induced aggression fought at higher rates and more strenuously than did naive animals (Hutchinson, Ulrich, and Azrin, 1965). These data suggest that environmental variables are important determinants of shock-induced aggression. The data also raise the question of the extent to which an incompatible operant might interfere with respondent behaviors, and conversely the extent to which a history of shock-induced aggression might impair the acquisition of such an operant. The experiments of Maier, Seligman, and Solomon (1969), for example, have shown that "inescapable" shocks retard later operant avoidance performance.

Several attempts to study the effects of shock-induced fighting on a free-operant baseline and on the acquisition of an operant response have been made by studying the avoidance behavior of paired animals, one or both of which have had avoidance or escape training. Since two animals are present simultaneously in the same enclosure, the probability of their fighting, when shocked, is high. Using the paired-subject procedure, Ulrich (1967) and Azrin, Hutchinson, and Hake (1967) investigated the effects of shock-induced fighting on the acquisition of avoidance and escape behaviors, and Ulrich and Crain (1964), and Ulrich, Stachnik, Brierton, and Mabry (1966) compared the baseline avoidance behaviors of paired and unpaired rats in a free operant avoidance paradigm. In general, these studies indicate that avoidance and escape behaviors are decreased as a function of the frequency of fighting between a pair of subjects, although as Azrin, *et.al.*, (1967) showed, this relationship is complicated because attack frequency is partially a function of the number of shocks received. Since shock frequency is under the animal's control, there is a constant interaction between the attack and escape tendencies of the animal.

The purpose of Experiment 1 in the present study was to investigate the effects of prior training with avoidance, fighting, or unavoidable shocks on shock-induced aggression while holding the frequency of shocks constant by means of a yoked-chamber design. Thus, shock-induced fighting was studied in animals that had received either (a) free-operant avoidance training, (b) exposure to shock-induced aggression, or (c) unavoidable shocks. A yoked design was used in which all animals received the same schedule of shocks. Experiments 2 and 3 were control experiments, the purpose

---

[1]Supported by NSF Grant GB 7944.

[2]NIMH Postdoctoral Fellow during the execution of a portion of this research. Reprints may be obtained from D. A. Powell, Veterans Administration Hospital, Columbia, South Carolina 29201.

of which was to determine further the shock-related variables producing fighting decrements.

EXPERIMENT I: EFFECTS OF PRIOR SHOCK AND EXPERIENCE WITH AVOIDANCE AND FIGHTING ON SHOCK-INDUCED AGGRESSION

Method

Subjects

Eight female Sprague-Dawley rats, obtained from Dublin Laboratories, were approximately 90 days of age at the beginning of the experiment.

Apparatus

The test enclosures consisted of two, two-bar rat chambers with identical dimensions, 9.25 by 8 by 9.75 in. (23.5 by 20.3 by 24.8 cm). The stainless steel parallel grid bars of the two enclosures were wired together so that the same pattern and frequency of shocks could be delivered to each chamber. Both chambers were housed in a refrigerator shell to attenuate extraneous noise and each was illuminated by separate 24-v dc lamps. A removable Plexiglas partition divided one or the other of the chambers into equal halves on alternate days. Shock was delivered to the grid floors of the chamber by a Grason-Stadler shock source and grid scrambler.

Procedure

The experiment was conducted in three stages. During the first stage, four rats were placed in the two yoked enclosures, a pair of animals in each box (See Figure 1). The animals of one pair were separated by a Plexiglas partition, while the second pair had unlimited access to each other within their enclosure. Shocks were presented to both boxes according to a prearranged free operant (Sidman) avoidance schedule, with the response of only a single rat of the four systematically related to the shock contingencies. The shocks occurred every 3 sec if this rat did not respond. Each response postponed shock for 20 sec. This animal, designated as the "avoid-subject", was always the same animal of the foursome and was always separated from its partner by the partition. Thus, through the depression of its bar, it could avoid or delay the shock, although neither the response of its partner, designated as the "no-response subject", nor the behavior of the other pair of rats, designated as "fighting subjects", was systematically related to shock onset or offset. It became apparent during this stage of the experiment that one of the fighting subjects in each group was more dominant than the other. This animal was the one that most often initiated attacks and was virtually always the one that pushed its partner to the grid floor when the pair fell to the floor in fighting. On the basis of these observations, the fighting animals were then designated as dominant and non-dominant. The animal with the active bar (see Figure 1), controlled all shock presentations for all rats. The baseline shock intensity was 2.5 mA, and the shock duration was 0.5 sec. Two groups of four animals each were given 2-hr daily sessions. After approximately 50 sessions, the avoidance baselines of the avoid subject in each group had become stable and the second stage of the experiment began.

During the second stage, the avoid subject was paired four times with each of the other three rats in its group and with the avoid subject from the other group. The order of the total of 16 pairings was counterbalanced. The Plexiglas partition was removed from the avoidance chamber during this time, and fighting behavior between the avoid subject and the other subjects recorded. Fighting frequencies were recorded over four consecutive 15-min periods by two independent observers. The fighting sessions occurred at the end of the normal 2-hr avoidance session, under the contingencies of the avoidance schedule. During those sessions, in which the two avoid subjects were paired, both bars were operative. Each of the avoid subjects could thus avoid shock by pressing either bar. However, the avoid subjects were trained on separate bars so that competitive aggression in response to the bar would be minimized. To keep baseline avoidance at optimum levels, these experimental sessions were alternated with control days, during which the partition was not removed and another rat thus not paired with the avoid subject.

Fighting frequencies between pairs of animals that did not include the avoid subject were determined in a third stage of the experiment, which began after completion of the second stage. The subjects, excluding the

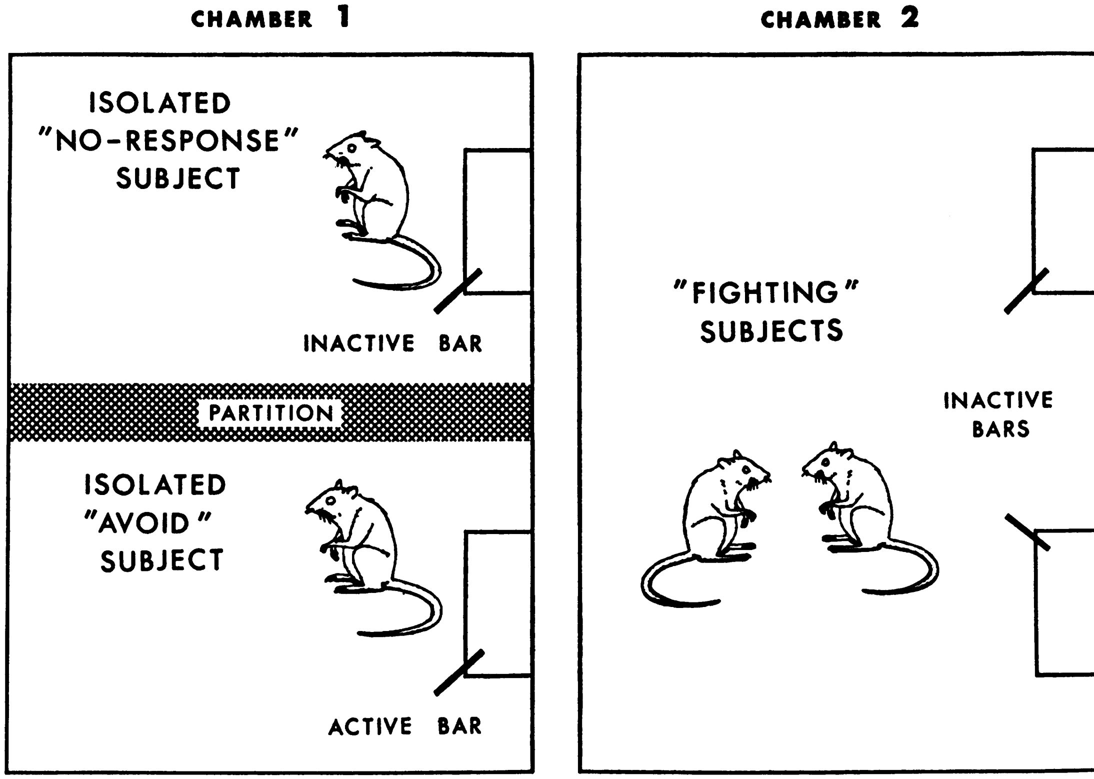

Fig. 1. Schematic representation of experimental design during Stage 1, in which different rats received experience with fighting, free operant avoidance, or unavoidable shock.

"avoid" rats, were paired in "round-robin" shock aggression sessions over four consecutive daily sessions. Orders of pairing within days were counterbalanced. Each shock session was 10 min in length and consisted of 200, 0.5-sec shocks at an intensity of 2.5 mA and a frequency of 20 shocks per minute. A fighting response was defined as one in which either one or both rats lunged, struck, or bit the other producing physical contact. Inter-observer agreement was consistently greater than 90%, and usually above 95%.

Results

All animals, when paired with the avoid animal with no partition present, disrupted the latter's avoidance baseline to some extent. However, this disruption was typically greater during earlier sessions and during the first quarter of a session. The extent of disruption also depended upon the behavioral history of the animal paired with the avoid rat.

Figure 2 shows the mean number of shocks received and the mean number of bar presses made per minute during sessions in which an avoid subject was matched with either a second avoid subject or subjects having other pre-training histories. Matching a no-response or a non-dominant fighter with the avoid subject disrupted the avoidance baseline less than did introduction of a second avoid subject or a dominant fighter. In general, disruption of baseline avoidance declined across sessions regardless of the pre-training history of the second rat. Thus, when the avoid subject was matched with a second avoid subject or the dominant fighter in Group 1, an increase in bar presses, associated with a pronounced decrease in shocks, was obtained over sessions. However, the avoidance baseline remained severely disrupted throughout testing in the presence of the dominant fighting subject in Group 2.

Although the avoid animals were trained on separate bars, they frequently pressed the other animal's bar during fighting sessions. However, rarely did both animals press at the same time. When extended avoidance occurred, it was primarily due to the responding of a single avoid animal. The other animal typically crouched on the opposite side of the chamber or assumed the upright fighting posture. In the latter case, if a shock occurred, the non-avoider usually attacked and the sequence of bar presses was almost invariably broken up. Similar kinds of behavior were shown by the other animals at various times, with the exception of the no-response subjects and to a lesser extent the non-dominant fighters. These animals were not as reactive to shock, and disruption of avoidance by these subjects usually occurred during the initial portions of the session and were initiated by the avoid subjects.

Avoidance behaviors were disrupted primarily by fighting, and fighting, like avoidance, varied for animals with different training histories. Mean fighting probability for each possible pairing of four animals over each of the four sessions is shown in Figure 3 for both groups. Fighting probability was defined as the ratio of fights to shocks. The data from pairs that included the avoid animal are based upon fighting that occurred under the contingencies of the avoidance schedule. The data for other pairs, obtained during the third stage of the experiment, are based upon four subsequent 10-min daily sessions in which 200, 0.5-sec shocks of 2.5 mA were given every 3 sec.

The first frame of Figure 3 shows that the probability of a fight occurring between the two fighting subjects was high. On the other hand, the fighting associated with the fighting subjects and the no-response subject differed, depending on which fighting animal was paired with the no-response animal. Frame 2 indicates that when a dominant fighter was paired with the no-response subject, a fairly high fighting probability was obtained, although the fighting behavior of this pair was not as stable as that between the fighting subjects. In contrast, as Frame 3 shows, the probability of fighting between the non-dominant fighters and the no-response subject was considerably lower. Again, between-session variability was greater than that shown by the

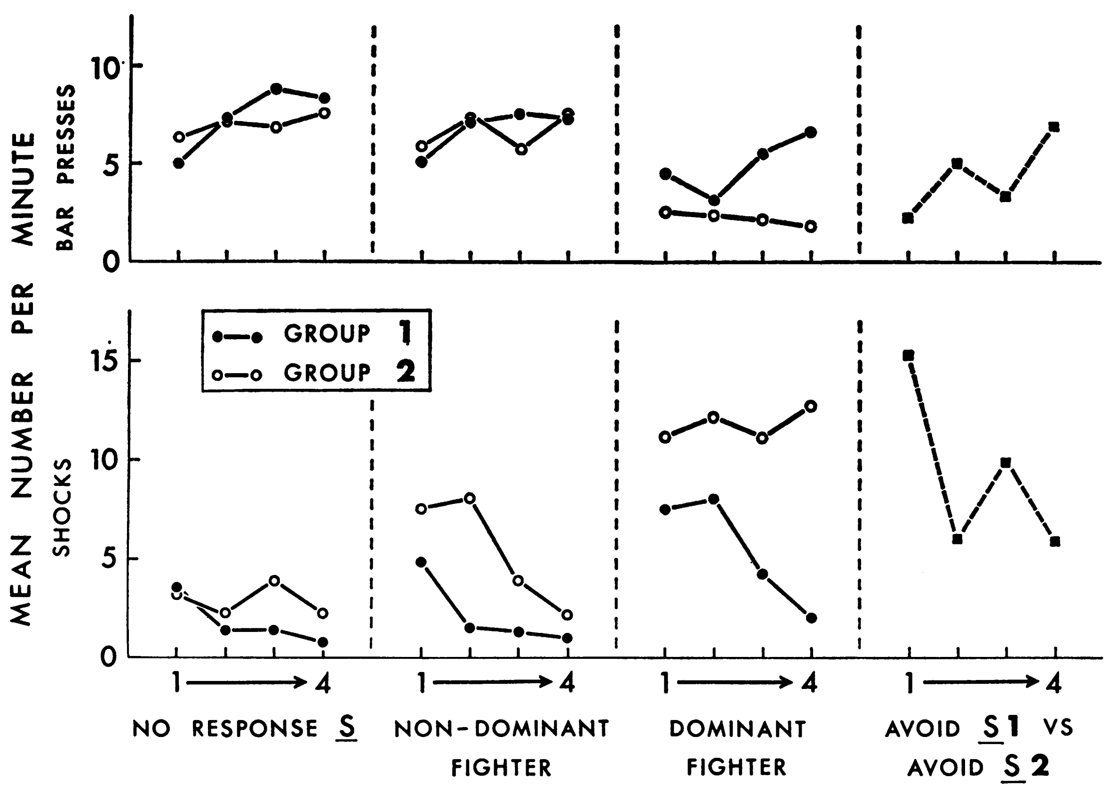

Fig. 2. Shocks (lower graph) and bar presses (upper graph) per minute when animals with different response-to-shock histories were paired with an avoidance-trained rat. The results of an initial experiment (Group 1) and a replication (Group 2) are shown.

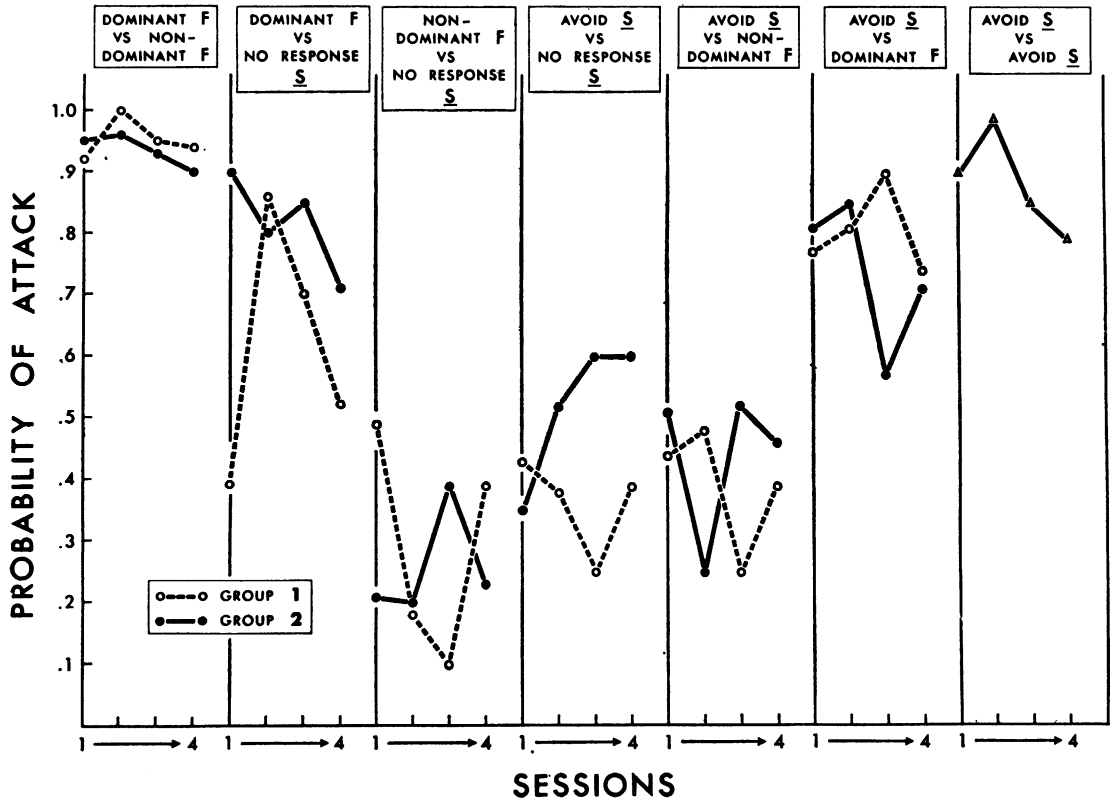

Fig. 3. Probability of attack in response to shock of rats with histories of different responses to shock, but the same shock schedule and frequency. "Dominant and non-dominant *Fs*" refers to subjects with fighting histories, "No-response *S*" refers to subjects that were isolated and could consequently neither fight nor avoid shock, and "Avoid *S*" refers to rats with a history of free operant avoidance. All fights involving "avoid rats" were observed under the contingencies of the avoidance schedule (response-shock interval, 20 sec, and shock-shock interval, 3 sec). Fights between the other rats were observed during four subsequent 10-min sessions of shock-induced aggression.

fighting pairs. Frames 4 to 6 further illustrate the behavior of the avoid subjects when matched with the other animals in the experiment. The fighting probability of the avoid subject was dependent upon the animal with which it was paired. If matched with another avoid subject or with a dominant fighter, fairly high fighting probabilities resulted. However, if paired with a non-dominant fighter or a no-response subject, considerably less fighting occurred.

Discussion

The finding that pairing rats in a free operant avoidance paradigm disrupts the normal avoidance baseline of a single animal supports the previous results of Ulrich and Crain (1964) and Ulrich, *et al.,* (1966). In agreement with these investigators, this disruption was directly related to fighting frequency (Azrin, *et al.,* 1967; Ulrich, 1967). The finding that rats previously trained to avoid show high rates of fighting when paired in a situation where it is possible to avoid shock entirely is not in full agreement with the results of Azrin, *et al.,* (1967), who found that attack responses retard escape behavior only during acquisition of the escape response. An important procedural difference in the latter study, however, was that one of the rats was restrained and unshocked, and thus could not interfere with the experimental animal's escape behavior. In the present experiment, both animals were free-moving and either could interfere with the other's attempts to press the bar. Under these conditions, fighting appears to be high in the rat's behavioral repertoire to noxious stimulation, suggesting that respondent properties associated with aggression interfere with ongoing operant behavior.

In agreement with the previous report of Powell and Creer (1969), animals with a prior history of unavoidable shock showed relatively low rates of fighting. Maier, *et al.* (1969) found that animals that could not make appropriate responses to shock also showed deficits in the later acquisition of an avoidance response. In the present experiment, isolated rats presented with unavoidable shock fought less than either dominant fighters or animals previously trained to make avoidance responses, their rates being comparable to nondominant rats with fighting experience. Thus, low fighting probabilities in rats can result from either a history of repeated attacks by more dominant animals or from a history of unavoidable electric shock.

A possible explanation of the decreased fighting of the "no-response" and less-dominant fighting subjects is that these animals learned a partial escape or pain-mitigation response that was incompatible with fighting and at the same time minimized the effects of shock. Other authors (Azrin and Holz, 1966; Azrin, *et.al.,* 1967) have noted that rats can escape shock via bar presses within 100 msec after shock onset. In the Azrin, *et al.* (1967) study, the acquisition of this behavior in the presence of another target rat resulted in fewer attacks by the escaping animal toward the target. As noted above, in the Azrin *et al.* (1967) study the target animals were restrained at a considerable distance from the bar. Thus, the incompatibility of escape and fighting in this experiment may have resulted from the physical separation of the target and the experimental animal. Although this kind of separation in the present study could only have been fortuitous, the latter subjects may have learned partial escape responses via postural adjustments on the grid during the training phase of the study. These partial escape responses thus may have later interfered with fighting during the testing stages of the experiment. Experiments 2 and 3 were conducted to investigate this problem in greater detail.

EXPERIMENT II: THE EFFECTS OF PRIOR GRID SHOCK ON SHOCK-ELICITED AGGRESSION

The acquisition of partial escape responses incompatible with fighting when rats are shocked with grid shock is possible even though a constant current shock generator is utilized. This is especially true if there are two animals on the grid. Changes in the impedance of one animal allow more current to flow to the other. Thus, in the procedure of the second experiment, pre-fighting shock was administered with only a single animal on the grid.

Method

Subjects

Twenty four female Sprague-Dawley rats, obtained from Dublin Laboratories, were approximately 90 days old at the beginning of the experiment.

Apparatus and Procedure

The apparatus was identical to that previously described, except that no partition or bar was present. In the 10 days before aggression testing each rat was individually placed in one of two test enclosures for a 5-min period. During this time, one of the animals of the pair received 100 presentations of either 2-mA or 1-mA, 0.5-sec duration grid shock at intertrial intervals of 3 sec. The animal in the other chamber received no shock. On the eleventh day of testing, the subjects were combined into pairs, three pairs that received 1 mA preshock-and three pairs that received 2 mA preshock. For each preshock pair, there was an adaptation pair that had been placed in the chamber with no shocks administered during the previous 10 days. Each pair was then administered 10 sessions of shock-induced fighting. Fighting was elicited by 2-mA, 0.5-sec trains of shock at intertrial intervals of 3 sec. Fighting was defined and recorded as in Experiment 1, and the shock parameters were continuously monitored by a milliameter. Although the observers were experienced, they were not aware of the purpose of the experiment until its completion, and thus had no knowledge of the prior experience of the animals tested.

Results and Discussion

Fighting frequency of individual pairs of animals, as a function of experimental sessions, is shown in Figure 4. Data are shown for the first, fifth, and tenth sessions. Rats that received prior shock showed fighting frequencies that were somewhat lower than those shown

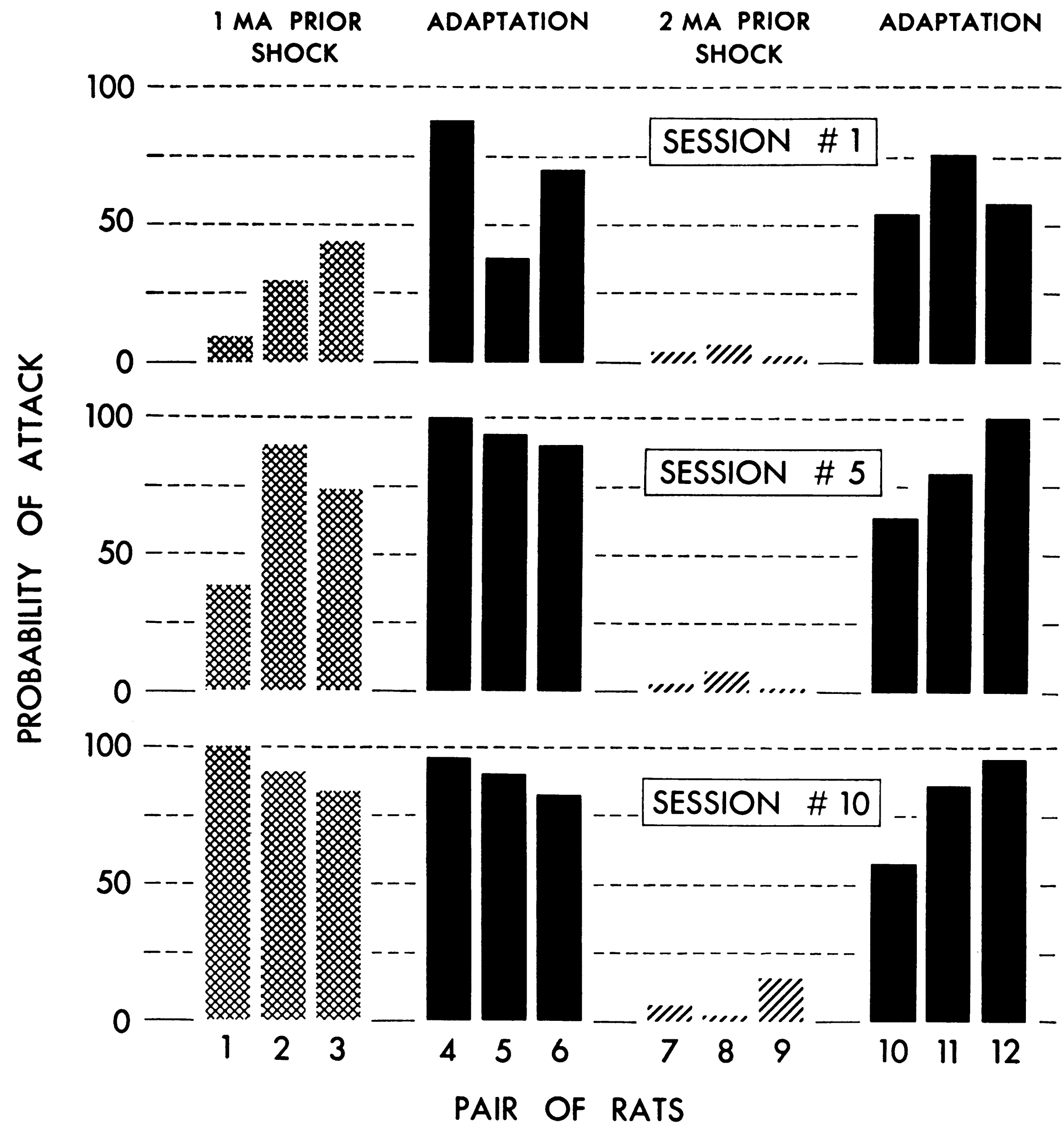

Fig. 4. Probability of attack in response to shock of rats given either adaptation, 1 mA, or 2 mA shocks before testing.

by rats that were adapted to the chamber during the first session of fighting, regardless of the shock intensity used during the pre-fighting sessions. As the experiment progressed, however, rats that were administered 1 mA prior shock showed increasing rates of fighting. Likewise, rats adapted to the experimental chamber showed higher rates of fighting during later sessions. However, the three pairs of animals that were administered 2 mA prior shock did not show this increase in fighting frequency over sessions. Rather, these rats continued to show extremely low rates of fighting. These results, for the most part, support those of Powell and Creer (1969) in which pairs of animals, separated by a partition, were administered prior grid shock, and their fighting rates later ascertained. The present results extend these findings to rats individually given prior shock and to animals administered 1 mA prior shock in addition to 2 mA shocks.

EXPERIMENT III: EFFECTS OF PRIOR TAIL SHOCK ON FIGHTING ELICITED BY GRID SHOCK

Although the data of Experiment 2 showed that rats individually administered prior grid shock subsequently exhibited less shock-elicited fighting than rats merely adapted to the enclosure, it is possible that these rats still learned to minimize the effects of shock by standing on certain grids, adopting particular postural adjustments, *etc.* Although this is less likely than in Experiment 1, where the "no-responses" rats received lengthy training on the same grid during the administration of shock, it is a possibility. The present experiment was thus designed to present the pre-fighting shock through tail electrodes that the animal could not displace. Thus, escape or avoidance of the shock was impossible in this experiment.

Method

Subjects

Twenty-four female Sprague-Dawley rats were used.

Apparatus

The pre-fighting shock was administered in a small Plexiglas enclosure that was adjustable in two dimensions. The rat was placed inside this enclosure and one side and the end pushed toward the animal and secured with thumb-screws, so that it was restrained in a fixed position and was thus unable to turn around. The tail extended from this enclosure through a slit in the back panel, and shock electrodes similar to those described by Weiss (1967) were applied. Briefly, these electrodes consisted of a 0.37 in. (1 cm) length of gum tubing (0.3 cm I.D.) slit down one side so that it could be slipped onto the animal's tail. An $\frac{8}{32}$ bolt was attached to the tube through a hole in its side and secured to the opposite side as an electrode. A small piece of circular rubber was cut from the finger of a surgical glove and stretched around the tubing to produce a tight fit. Two identical electrodes, one positive and one negative, were constructed and applied over an area of the tail previously cleaned and prepared with Bentonite paste. We found that if both electrodes were attached to the same piece of tubing as Weiss (1967) suggested, the paste invariably shorted the two electrodes, so that little if any current went through the higher resistance tail of the rat. This feature of these electrodes may have been due to the many times they were attached and unattached in the present application. The animals were later tested for shock-elicited fighting in the apparatus described in Experiments 1 and 2.

Procedure

The rats were divided into 12 pairs and these pairs further randomly divided into two groups of six pairs each. Each subject of one group received 10 daily 5-min sessions in the small enclosure with electrodes attached, but no shock administered (adaptation group). The second group was treated identically, except that 10-mA, 0.5-sec shock trains were administered at a frequency of 20 shocks per minute. Several additional rats were also given 2-mA tail shocks, but they appeared to adapt to this shock intensity within a single session, and it was consequently dropped from the study. Thus, all rats were administered either 0- or 10-mA shocks. Each subject administered pre-fighting shock received 100 total shocks per daily session for 10 days. On the eleventh day of the experiment, all rats were paired on a shock grid and tested for shock-elicited aggression. The shock parameters for eliciting fighting were 2-mA, 0.5-sec shocks at a frequency of 20 shocks per minute. Five daily sessions consisting of 100 shocks per session were administered. Fighting was defined and measured as in previous experiments. The observer had no knowledge of the group to which any pair of rats belonged.

Results and Discussion

The fighting frequency scores of each pair of rats over days are depicted in Figure 5. Superimposed on the individual data are the mean fighting frequencies of the two groups. Rats given prior electrode shock showed higher rates of fighting than did rats previously adapted to the chamber during all except the first session. Only one, (and occasionally two) of the pairs in the adaptation group showed frequencies comparable to those shown by rats given prior shock. Analysis of variance revealed the differences between the groups to be reliable ($P < 0.001$, $F = 5.97$, $df = 1/10$). Thus, contrary to the results of Experiments 1 and 2, animals given prior shock in the pres-

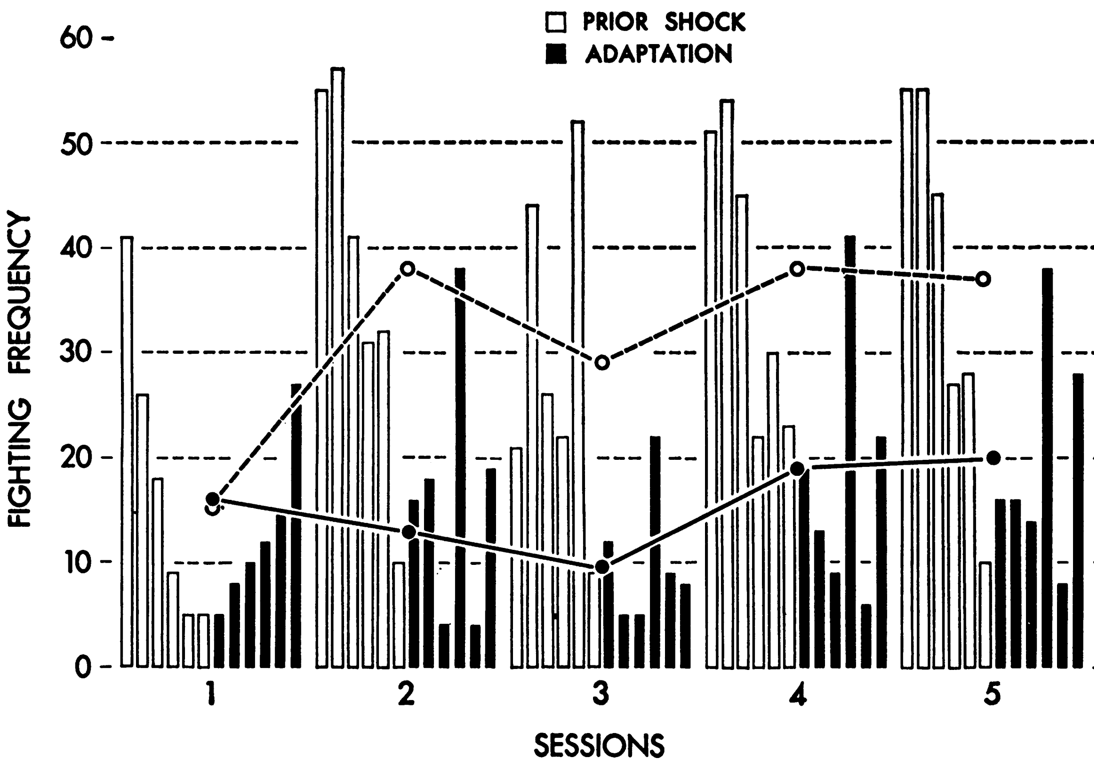

Fig. 5. Fighting frequency of individual rats previously administered 10-mA tail shock or adapted to the enclosure. Mean fighting frequency is superimposed over individual data.

ent experiment showed higher rates of fighting than rats not given prior shock. In the present experiment, prior shock was administered via electrodes to the tail and was of a higher intensity than that used in the prior experiments. The present results thus suggest that when shock is administered in such a way as effectively to preclude responses that mitigate against its aversive effects, it augments rather than interferes with aggression elicited by shock.

GENERAL DISCUSSION

The present results showed that the prior administration of electrical shock can have a dramatic influence on the subsequent frequencies of shock-elicited fighting shown by rats. However, apparently both the kind of training that the animal receives, as well as the method of shock presentation, influences the specific effects of such prior stimulation. Thus, both dominant rats with fighting histories and rats with avoidance histories showed relatively high rates of fighting in response to shock. These findings agree with those of other investigators (*e.g.*, Ulrich and Crain, 1964; Ulrich, *et al.*, 1966). On the other hand, non-dominant rats with fighting histories and rats with a prior history of neither avoidance nor fighting (isolated rats) showed lower fighting frequencies in response to shock. Finally, if prior shock is presented to the feet via metal grids, fighting decreases, but if it is presented via fixed tail electrodes, fighting increases.

Other investigators have reported that treatment with shock before the measurement of some response can either augment or diminish the frequency or magnitude of such responses depending upon the behavior being studied, the species used, *etc.* (Anderson, Cole, and McVaugh, 1968; Overmier and Seligman, 1967; Payne, Anderson, and Murcurio, 1970). Of some concern in these experiments is the mechanism(s) by which these changes in response probabilities occur. One possible explanation is that the acquisition of responses during the prior training phase interferes with or augments the subsequent occurrence of similar responses in the test phase of the experiment. It has been suggested, for example, that the freezing response in rats, produced by presentation of shock, facilitates the later acquisition of a passive avoidance response; it would, of course, interfere with active avoidance. An alternative explanation involves the production, during the training phase via prior stress-inducing stimulation (shock), of biochemical or physiological changes unrelated to response acquisition. These latter "performance" changes would then either mitigate against or facilitate behavior in the later test stages of the study. Carlton (1968), for example, suggested that parasympathetic rebound produced by stress-induced sympathetic activities interferes with the acquisition of certain behaviors. Although the present results are not conclusive, the non-homogeneity of foot shock suggests that when it is used as a prior stressor, incompatible partial avoidance or escape responses are learned during training and subsequently interfere with the elicitation of fighting during testing. On the other hand, when shock was administered in such a way as to preclude the acquisition of such responses, shock-elicited aggression was augmented. While the former finding illustrates the interaction of the respondent and operant properties of shock-elicited aggression, and is compatible with Azrin, *et al.*,'s (1967) results, the latter results are compatible with the original interpretation of pain-induced aggression as basically a respondent behavior (Ulrich and Azrin, 1962). Obviously, however, these relationships are complicated, and further experiments in which the magnitude and duration of prior stress is systematically studied will be required before definitive conclusions can be drawn.

REFERENCES

Anderson, D. C., Cole, J., and McVaugh, W. Variations in unsignaled inescapable preshock as determinants of responses to punishment. *Journal of Comparative and Physiological Psychology; Monograph Supplements,* 1968, **65,** 1-17.

Azrin, N. H. and Holz, W. C. Punishment. In W. K. Honig (Ed.), *Operant behavior: areas of research and application.* New York: Appleton-Century-Crofts, 1966. Pp. 380-447.

Azrin, N. H., Hutchinson, R. R., and Hake, D. F. Attack, avoidance, and escape reactions to aversive shock. *Journal of the Experimental Analysis of Behavior,* 1967, **10,** 131-149.

Carlton, P. L. Cholinergic mechanisms and the control of behavior. *Psychopharmacology: a review of progress 1957-1967.* D. H. Efron; J. O. Cole; J. Levine; and J. R. Wittenborn (Eds.), U.S Public Health Service, Publication No. 1836, 1968. Pp. 125-138.

Hutchinson, R. R., Ulrich, R. E., and Azrin, N. H. Effects of age and related factors on the pain-aggression reaction. *Journal of Comparative and Physiological Psychology,* 1965, **59,** 365-369.

Lorenz, K. *On aggression* (Translated by Marjorie K. Wilson). New York: Harcourt, Brace and World, 1966.

Maier, S., Seligman, M. E., and Solomon, R. L. Fear conditioning and learned helplessness. In Russell Church and Byron Campbell (Eds.), *Punishment and aversive behavior,* Appleton-Century-Crofts, 1969. Pp. 299-342.

Overmier, J. B. and Seligman, M. E. Effects of inescapable shock upon subsequent escape and avoidance responding. *Journal of Comparative and Physiological Psychology,* 1967, **63,** 28-33.

Payne, R., Anderson, D. C., and Murcurio, J. Preshock-produced alterations in pain-elicited fighting. *Journal of Comparative and Physiological Psychology,* 1970, **2,** 258-266.

Powell, D. A. and Creer, T. L. The interaction of some environmental and developmental variables in shock-induced aggression. *Journal of Comparative and Physiological Psychology,* 1969, **69,** 219-225.

Powell, D. A., Francis, J., Bramen, M. J., and Schneiderman, N. Stimulus characteristics of the opponent in shock-elicited aggression. *Journal of the Experimental Analysis of Behavior,* 1969, **12,** 817-823.

Ulrich, R. E. Interaction between reflexive fighting and cooperative escape. *Journal of the Experimental Analysis of Behavior,* 1967, **10,** 311-317.

Ulrich, R. E. and Azrin, N. H. Reflexive fighting in response to aversive stimulation. *Journal of the Experimental Analysis of Behavior,* 1962, **5,** 511-520.

Ulrich, R. E. and Crain, W. H. Behavior: Persistence of shock-induced aggression. *Science,* 1964, **143,** 971-973.

Ulrich, R. E., Stachnick, T. J., Brierton, G. R., and Mabrey, J. H. Fighting and avoidance in response to aversive stimulation. *Behavior,* 1966, **26,** 124-129.

Weiss, J. A tail electrode for unrestrained rats. *Journal of the Experimental Analysis of Behavior,* 1967, **10,** 85-86.

Received: 10 November 1969
Final acceptance: 4 May 1972